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BULLETIN

OF THE

TORREY BOTANICAL CLUB

Contributions to the Mesozoic flora of the Atlantic coastal plain, XII.—Arkansas*

Edward W. Berry

(with plate 7)

The Upper Cretaceous of the Western Gulf area contains littoral sand beds of a magnitude great enough to be considered formational units. These are not restricted to a narrow horizon and the belief has been frequently expressed and is apparently probable that these sand formations are the time equivalents of several marine formations that are differentiated elsewhere in this area. The Woodbine sand of northeastern Texas is a case in point and another example is furnished by the Bingen sand of southwestern Arkansas. Both are without marine fossils so far as known and both contain fossil plants, those of the Woodbine sand having been reviewed by me† in 1912.

Recently Mr. H. D. Miser, of the United States Geological Survey, has sent me several small collections of fossil plants from the Bingen sand. These are, so far as I know, the first fossil plants collected from the Bingen sand. While the material is poor and not greatly varied, a number of species are determinable and these, while not as conclusive as might be wished, nevertheless shed considerable light on the correlation of the formation. Mr. Miser is to be congratulated for the care with which he has collected from such unpromising material.

The Bingen sand was named by Hill in 1888‡ from the town

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* The last previous contribution of this series appeared in the Bull. Torrey Club **43**: 283–304. *pl. 16.* 1916.

† Berry, E. W. No. VIII of this series. Bull. Torrey Club **39**: 387–406. *pl. 30–32.* 1912.

‡ Hill, R. T. Ann. Rept. Geol. Surv. Arkansas for 1888, **2**: 56–58.

of Bingen in Hempstead County, Arkansas. It comprises near shore (littoral and estuarine) deposits of gravels and white to brown sands and clays with considerable lignitic material and occasionally fairly well preserved fossil plants. It outcrops in a nearly east and west direction commencing at the Ouachita River and showing isolated patches along the edge of the Paleozoic rocks in Clark County. Except where it is cut out by river bottoms it forms an almost continuous sheet across Pike, Hempstead, Howard and Sevier Counties. Veatch,* who mapped this area in 1902 and 1903, clearly recognized that while the Bingen sand of southwestern Arkansas was the lithologic counterpart of the Woodbine sand of northeastern Texas it was the chronological equivalent of not only more or less of the Woodbine but of a considerable portion of the overlying Upper Cretaceous, including at least all of the Eagle Ford formation of the Texas region and possibly the Austin and the earlier part of the Brownstown formation. Mr. Miser in his recent work in the Caddo Gap and De Queen quadrangles proposes to distinguish a lower and an overlapping upper Bingen, both of which have furnished fossil plants, although the collections from both are not far from the contact of the two and therefore well above the base of the Bingen in the one case and well below the top in the other.

The plants include twenty-seven determinable species for the most part identical with well-known Upper Cretaceous forms, and a fern pinnule that I have not ventured to name. The determined forms comprise one fern, four conifers, two cycadophytes (?), and twenty dicotyledons. The most abundant forms are *Sequoia concinna* and a new species of *Dewalquea*. Among the dicotyledons there are three species each of *Myrica* and *Ficus*, two each of *Salix*, *Liriodendron* and *Andromeda*, and one each of *Dewalquea*, *Menispermites*, *Colutea*, *Leguminosites*, *Manihotites*, *Cinnamomum*, *Sapindus* and *Cordia*. A list of the species with their outside distribution is shown in the accompanying table.

The largest collection (seventeen species) and the best preserved material comes from the Big Railroad Cut locality which is near the base of Mr. Miser's upper Bingen. Considering the Bingen flora as a whole it may be noted that it contains only one species—the abundant *Dewalquea*—not known from other Upper Cretaceous formations of the Atlantic Coastal Plain. There are five species common to the little known flora of the Woodbine sand of northeastern Texas. Eighteen of the Bingen species occur in the Tuscaloosa formation of the Eastern Gulf area, six continue upward into the Eutaw formation and one is found as high as the Ripley. Eleven species are common to the Dakota sandstone of the Western Interior and an identical number ranges northward far enough to be present in the Atane beds of western Greenland. Fifteen of the Bingen plants are recorded from the Black Creek formation of the Carolinas and there are seventeen common forms in both the Raritan and Magothy formations of

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* Veatch, A. C. U. S. Dept. Int. Geol. Surv. Professional Paper 46: 24. 1906.

	Big Railroad Cut near Maxwell Spur, Pike County	Adams' Kaolin Cuts near Murfreesboro, Pike County	Mine Creek near Nashville, Howard County	Woodbine	Tuscaloosa	Eutaw	Ripley	Black Creek	Dakota	Raritan	Magothy	Atane	Patoot	Colorado	Montana	Cenomanian	Turonian
Fern pinnule		×															
Dicksonia groenlandica		×	×		×					×		×	×				
Sequoia concinna	×				?					?	×		×			?	?
Sequoia heterophylla	×				×			×		×	×	×	×		×	×	
Widdringtonites subtilis	×				×			×		×	×	×					
Araucaria darlingtonensis	×				×			×									
Podozamites marginatus		×			×					×	×	×					
Podozamites sp.			×														
Myrica cliffwoodensis	×							×			×						
Myrica longa			×	×	×				×		×	×	×				×
Myrica cinnamomifolia			×							×							
Salix flexuosa	×	×	×		×	×		×	×	×	×						
Salix Lesquereuxii	×	×			×			×	×	×	×						
Ficus crassipes	×	×	×		×	×		×	×		×	×					
Ficus daphnogenoides	×			×	×			×	×	×	×						
Ficus ovatifolia (?)			×			×		×		×							
Dewalquea insigniformis	×	×															
Liriodendron Meekii	×				×			×	×	×		×					
Liriodendron quercifolium			×	×						×							
Menispermites integrifolia	×				×												
Colutea primordialis	×			×					×	×	×	×					
Leguminosites omphalobioides	×				×				×		×						
Manihotites georgiana	×					×	×	×									
Sapindus Morrisoni	×		×	×				×	×		×	×	×				
Cinnamomum Newberryi (?)			×		×	×		×	×	×	×	×	×				
Andromeda novae-caesareae			×		×	×		×		×	×						
Andromeda Parlatorii			×		×			×	×	×	×	×					
Cordia apiculata	×				×					×	×						

the northern Atlantic coastal plain. This serves to fix the age of the Bingen within the somewhat broad limits extending from the base of the Raritan to the base of the Ripley. The chief interest in the present contribution is, however, the somewhat more definite indications of age furnished by these collections.

The first two localities, namely the Big Railroad Cut and Adams Kaolin cuts in Pike County, are definitely located by Mr. Miser in the lower part of the upper Bingen and I shall consider these first. A total of nineteen species are determined. Of these three occur in the Woodbine and fourteen occur in the Tuscaloosa, eleven in the Raritan, thirteen in the Magothy, eleven in the Black Creek, three in the Eutaw and one in the Ripley. Among the upper Bingen plants are eight that are unknown as early as the Raritan. This fact and the presence of the *Manihotites*, which is a characteristic Eutaw and Ripley species, indicates that the upper Bingen is to be correlated with a part, presumably the upper, of the Woodbine, with the upper part of the Tuscaloosa and with the Eutaw formation of the Eastern Gulf area.

The correlation of the upper Bingen with the Eutaw confirms the suggestion of Veatch that it represents the interval during which the Eagle Ford formation was deposited throughout the Texas area, and as he and other students have suggested it may include the chronologic equivalent of still higher formations differentiated in Texas. This can only be determined paleobotanically by the discovery of more abundant materials from a number of horizons.

The locality in Howard County has furnished but twelve species, only four of which are found in the upper Bingen. It has not furnished any trace of the *Dewalquea* which is so common and characteristic a form in the upper Bingen nor are any of the four conifers of the latter represented. Forms like *Myrica cinnamomifolia* and *Liriodendron quercifolium*, peculiar to the Raritan, indicate that the lower Bingen is to be correlated with the Raritan, the lower Tuscaloosa and a part, presumably the lower, of the Woodbine.

The boundaries of all of the Upper Cretaceous formations of the Coastal Plain, determined as they have been by lithological differences instead of by their contained faunas or floras, overlap, and the limits of the same formation are not chronologically coterminous when traced from locality to locality, so that final precision in correlation must wait for the discovery and study of abundant paleontological materials.

The species that have been determined from the Bingen sand are discussed in the following pages. This discussion is in most cases brief and only one or two important references to the literature are cited.

FILICALES

CYATHEACEAE

DICKSONIA Presl

DICKSONIA GROENLANDICA Heer

Dicksonia groenlandica Heer, Fl. Foss. Arct. **6**^{2}: 23. *pl. 35. f. 8, 9.* 1882.

Dicksonia borealis Heer, *Ibid. pl. 44. f. 2.*

Anemia stricta Newberry, Fl. Amboy Clays 38. *pl. 3. f. 1, 2.* 1896.

This characteristic species, which has a considerable vertical range in the Upper Cretaceous of the west coast of Greenland, is common in the middle Raritan of New Jersey and also occurs in the lower part of the Tuscaloosa formation of western Alabama. It is sparingly represented in both the lower and upper Bingen in Arkansas.

OCCURRENCE: Kaolin cuts in sec. 24 T8S. R24. W, Pike County; Mine Creek, three and one half miles north of Nashville, Howard County.

CYCADALES (?)

CYCADACEAE (?)

PODOZAMITES Fr. Braun

PODOZAMITES MARGINATUS Heer

Podozamites marginatus Heer, Fl. Foss. Arct. **6**^{2}: 43. *pl. 16. f. 10.* 1882.

This species was originally described from the Atane beds of western Greenland. It occurs in the Raritan formation of New Jersey and Maryland, in the Magothy formation of New Jersey, and is very common in the lower part of the Tuscaloosa formation in western Alabama.

OCCURRENCE: Adams Kaolin cuts near Murfreesboro, Pike County.

PODOZAMITES sp.

Small fragments of a species of *Podozamites* occur in the collection from the east part of Section 2, but whether they represent *Podozamites marginatus*, which occurs elsewhere in the Bingen sand, as well as in the Tuscaloosa formation of the Eastern Gulf area, or some other of the numerous Cretaceous forms referred to this genus it is impossible to determine.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

CONIFERALES

PINACEAE

SEQUOIA Endlicher

SEQUOIA HETEROPHYLLA Velenovsky

Sequoia heterophylla Velenovsky, Gym. Böhm. Kreidef. 22. *pl. 12. f. 12; pl. 13. f. 2–4, 6–9.* 1885.

This characteristic species, described originally from the Cenomanian of Bohemia, may be readily recognized by the form of the foliage—the flat, lanceolate, decurrent leaves above, and the short and appressed leaves below. It has a wide geographical range as may be seen from the accompanying table of distribution. It has not yet been found but probably will be eventually discovered in the Woodbine sand, since it is not uncommon in the Tuscaloosa beds of western Alabama.

A considerable number of fragmentary but characteristic specimens have been collected from near the base of the upper part of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

SEQUOIA CONCINNA Heer

Sequoia concinna Heer, Fl. Foss. Arct. 7: 13. *pl. 49. f. 8b, c; pl. 50. f. 1b; pl. 51. f. 2–10; pl. 52. f. 1–3; pl. 53. f. 1b.* 1883; Berry, Geol. Surv. of New Jersey, Bull. 3: 96. 1911.

This species (FIGS. 1–5) was described by Heer from the Patoot beds of Greenland and has subsequently been recorded from the Raritan and Magothy formations of the United States and from the Emscherian of Italy. The foliage is distinguished with difficulty from that of *Sequoia fastigiata* (Sternberg) Heer, *Sequoia ambigua* Heer, and various other species. In the absence of well preserved cones it is doubtful if the species can be determined. Similar foliage from the Tuscaloosa formation of western Alabama I have referred to *Sequoia fastigiata*. The reference of the Bingen sand material to *S. concinna* rather than to the latter species is due to the presence of cones associated with the twigs in the latter formation.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

WIDDRINGTONITES Endlicher

WIDDRINGTONITES SUBTILIS Heer

Widdringtonites subtilis Heer, Fl. Foss. Arct. 3^2: 101. *pl. 28. f. 1b.* 1874. Berry, U. S. Dept. Int. Geol. Surv. Professional Paper 84: 25. *pl. 2. f. 14–17.* 1914.

This species was described from the Atane beds of Greenland by Heer in 1874. His material was, however, extremely limited. Subsequently it was found in considerable abundance in the Raritan formation of New Jersey, and still more recently Hollick recorded it from Marthas Vineyard and Block Island (Magothy formation). It may be questioned if some of the coniferous material described by Velenovsky from the Bohemian Cretaceous under other names should not be compared with the present form. It is even more slender than *Widdringtonites Reichii*, with much shorter twigs, which have the appearance of having been somewhat lax in habit. The leaves are usually more elongated, close set, and appressed, narrowly lanceolate, straight and scalelike; they are said by Heer to be somewhat spread and falcate proximad. Remains of this latter sort occur in the Tuscaloosa formation of Alabama where they bear characteristic valvate cones like those of the existing *Widdringtonia*.

This species has not yet been discovered in the Woodbine sand of Texas but its remains are very abundant in the lower part of the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

ARAUCARIA Jussieu

ARAUCARIA DARLINGTONENSIS Berry

Araucaria darlingtonensis Berry, U. S. Dept. Int. Geol. Surv. Professional Paper 84: 20. *pl. 3. f. 1.* 1914.

Seed obovate in outline with broadly rounded apex, straight lateral margins, and somewhat narrowed rounded base, 1.25 cm. in length and 0.75 cm. in width across the widest part, 0.5 cm. wide at base.

This species was based on the seed of an araucarian conifer from the Middendorf member of the Black Creek formation of South Carolina where it was associated with the foliage of *Araucaria bladenensis* Berry. A single specimen is contained in the collection from the basal part of the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

MYRICALES

MYRICACEAE

MYRICA Linné

MYRICA CLIFFWOODENSIS Berry

Myrica cliffwoodensis Berry, Bull. Torrey Club **31**: 73. *pl. 4. f. 1.* 1904.

This species was based on small spherical fruits of the *Myrica* type from the Magothy formation of New Jersey which were subsequently found in the Black Creek formation of North Carolina. Similar fruits are extremely common in some of the pieces of clay from the basal part of the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

MYRICA CINNAMOMIFOLIA Newberry

Myrica cinnamomifolia Newberry, Fl. Amboy Clays 64. *pl. 22. f. 9–14.* 1896.

The finding of this species in the lower member of the Bingen sand is of considerable interest since it has heretofore been known only from the middle part of the Raritan formation in the New Jersey area where it is not uncommon. Its reference to the genus *Myrica* is questionable.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

MYRICA LONGA (Heer) Heer

Proteoides longus Heer, Fl. Foss. Arct. 3^2: 110. *pl. 29. f. 8b; pl. 31. f. 4, 5.* 1874.

Myrica longa Heer, *Ibid.* 6^2: 65. *pl. 18. f. 9b; pl. 29. f. 15–17; pl. 33. f. 10; pl. 41. f. 4d.* 1883.

Leaves of various sizes, linear to lanceolate in outline, with a stout midrib; numerous thin, ascending, camptodrome secondaries; entire margins, obtusely pointed apex; narrowly decurrent base and long stout petioles.

This species was described by Heer as a *Proteoides* and subsequently referred to the genus *Myrica.* It occurs in both the Atane and Patoot beds of Greenland, in the Dakota sandstones of the West, in the Magothy formation of Maryland, in the Woodbine formation of Texas, and is very common in the Tuscaloosa formation of Alabama. It is sparingly represented in the lower member of the Bingen sand. Abroad it has been recorded* from the lower Turonian of Bohemia.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

SALICALES

SALICACEAE

SALIX Linné

SALIX FLEXUOSA Newberry

Salix flexuosa Newberry, Later Ext. Floras 21. 1868.

Salix flexuosa Berry, U. S. Dept. Int. Geol. Surv. Professional Paper 84: 32, 109. *pl. 7. f. 14–16; pl. 11. f. 1.* 1914.

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* Frič, Archiv. Naturw. Landes Böhm. 4: 18, 94. 1874.

Leaves narrow, linear-lanceolate in outline, equally pointed at both ends, short petioled, 5–10 cm. in length and 8–13 mm. in maximum width. Margins entire. Midrib stout below, tapering above, often somewhat flexuous. Secondaries more or less remote, about ten alternate pairs, branching from the midrib at angles varying from thirty-five to forty-five degrees, camptodrome, of fine caliber, often obsolete.

This species was described by Newberry from the Dakota sandstone. Lesquereux subsequently made it one of the varieties of his *Salix proteaefolia*, although it is obviously entitled to independent specific rank. It is of rare occurrence in the Raritan formation of New Jersey, and is preëminently a species which characterizes the Magothy formation from New Jersey to Maryland, and homotaxial horizons to the southward. It is recorded in beds of Magothy age from Marthas Vineyard to the Potomac River. It occurs in the Black Creek beds of North and South Carolina, and in the Middendorf member in the latter state. In Georgia, while not especially abundant, characteristic leaves of this species are found from the base to the top of the lower Eutaw formation in the western part of the state. In Alabama it is very common at a relatively large number of localities from the base to the top of the Tuscaloosa formation. It appears to be a common form in the Bingen sand occurring in both the lower and upper members.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur; Adams Kaolin cuts near Murfreesboro, Pike County; Mine Creek, three and one half miles north of Nashville, Howard County.

SALIX LESQUEREUXII Berry

Salix proteaefolia Lesquereux, Cret. Fl. 60. *pl. 5. f. 1–4.* 1874.

Salix Lesquereuxii Berry, Bull. Torrey Club **37**: 21. 1910.

Leaves ovate-lanceolate in outline, somewhat more acuminate above than below, variable in size, 6–12 cm. in length and 1.1–2.2 cm. in greatest width, which is usually slightly below the middle. Petiole stout, much larger than in *Salix flexuosa*, ranging up to 1.2 cm. in length. Midrib stout below, tapering above. Secondaries numerous, sometimes as many as twenty pairs; they branch from the midrib at angles of about forty-five degrees and are parallel and camptodrome.

This is an exceedingly variable species, and Lesquereux established several varieties of which at least one, *i. e.*, var. *linearifolia*, referable to *Salix flexuosa* Newberry. Some of Lesquereux's forms are distinguishable with difficulty from the latter. In general, *Salix Lesquereuxii* is a relatively much broader, more ovate form with more numerous and better seen secondaries and a longer petiole.

This species is an exceedingly abundant Upper Cretaceous type in both the East and the West, ranging in the Atlantic Coastal Plain from the base of the Raritan formation to the top of the Tuscaloosa formation, and possibly through the Eutaw formation as well. It is abundant in the Magothy, Black Creek, and Middendorf beds. In the West it is common in the Dakota sandstone. It is one of the forms recorded by Kurtz from the Upper Cretaceous of Argentina, indicating, if the identification is correct, a very considerable migration during the early Upper Cretaceous. In Alabama it ranges from the bottom to the top of the Tuscaloosa formation.

It has not yet been discovered in the Woodbine sand of Texas but appears to have been common in the upper member of the Bingen sand of Arkansas.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur; Adams Kaolin cuts near Murfreesboro, Pike County.

URTICALES

MORACEAE

FICUS Linné

FICUS DAPHNOGENOIDES (Heer) Berry

Proteoides daphnogenoides Heer, Phyll. Crét. d. Nebr. 17. *pl. 4.* 1866.

Ficus daphnogenoides Berry, Bull. Torrey Club 32: 327. *pl. 21.* 1905.

This species has been found to be quite variable in size, ranging in length from 11 cm. to 22 cm. and in width from 1.9 cm. to 3.7 cm. It is usually widest in the lower half of the leaf, although sometimes the base is quite narrow and the widest part is toward the middle. In all unequivocal material the upper half of the leaf is narrow and is produced as a long, slender, often recurved tip, which is one of the characteristic features of the species. This tip is strictly comparable with the "dripping points" developed on various leaves in the modern tropics where precipitation is heavy.

Ficus daphnogenoides is a widespread and common form ranging from Marthas Vineyard to Texas in eastern North America, and from Northwest Territory to Kansas and Nebraska in the Western Interior. It occurs in the Woodbine sand of northeastern Texas and in the Tuscaloosa formation of the Eastern Gulf area.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

FICUS CRASSIPES (Heer) Heer

Proteoides crassipes Heer, Fl. Foss. Arct. 3^2: 110. *pl. 31. f. 6–8a.* 1874.

Ficus crassipes Heer, *Ibid.* 6^2: 70. *pl. 17. f. 9a; pl. 24. f. 1, 2.* 1882.

Leaves entire, narrowly lanceolate in outline, about equally tapering to the acuminate apex and base. Length 12–20 cm. Greatest width, which is in the middle part of the leaf, 1.8–2.5 cm. Texture coriaceous. Midrib stout, often extraordinarily so. Secondaries thin, open, ascending, camptodrome.

This species was described originally from the Atane beds of western Greenland, the first rather fragmentary specimens collected suggested a relationship with the genus *Proteoides*. Subsequently the original describer referred it to *Ficus*, where it undoubtedly belongs. Lesquereux has recorded it from the Dakota sandstone and it is common in the Magothy formation of the northern Atlantic Coastal Plain, and in the Black Creek formation of North Carolina. It persists into the Eutaw formation of Georgia and is especially common in the Middendorf beds of South Carolina. It is not especially common in the Tuscaloosa formation, and is a species which is especially characteristic of the post-Raritan and pre-Montana horizons of eastern North America. It has not yet been discovered in the Woodbine sand of Texas but is present in both the lower and upper members of the Bingen sand of Arkansas.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur; Adams Kaolin cuts near Murfreesboro, Pike County;

Mine Creek, three and one half miles north of Nashville, Howard County.

FICUS OVATIFOLIA Berry (?)

Ficus ovata Newberry, Mon. U. S. Geol. Surv. **26**: 70. *pl. 24. f. 1–3.* 1896. Not Don, 1802–3.

Ficus ovatifolia Berry, Bull. Torrey Club **36**: 253. 1909.

Leaves ovate in outline, extended above into a narrow, usually pointed apex. Length 8–12 cm. Greatest width, which is in the basal part of the leaf, 4–7 cm. Base broadly rounded and in many specimens slightly decurrent. Margins entire. Primaries, three from the base, the midrib somewhat stouter than the lateral primaries. Secondaries camptodrome.

This species is closely allied to the Raritan species *Ficus Woolsoni* Newberry, differing primarily in its greater elongation and in the tendency of the former to a cordate outline. *Ficus ovatifolia* was described originally from the Raritan formation of New Jersey. It is present in the Black Creek formation of North Carolina and in the Eutaw formation in Georgia and Tennessee. The Bingen material is fragmentary and not certainly identified.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

RANALES

RANUNCULACEAE (?)

DEWALQUEA Saporta & Marion

Dewalquea insigniformis sp. nov.

Leaves digitate, of probably five leaflets. Leaflets linear-acuminate with prominently serrate margins. Length about 12 cm. Maximum width mostly 1–1.25 cm., at or slightly above the middle. Base very gradually narrowed and with entire margins for a distance of about 2 cm. Midrib stout, prominent on the under surface of the leaflets. Secondaries numerous, diverging from the midrib at angles of from thirty to forty degrees, long ascending and eventually camptodrome, sending off small outwardly directed branches to the marginal teeth. Texture coriaceous. [FIGS. 6, 7.]

This characteristic new species with its coriaceous texture must have had rather stiff strict leaves in life. It adds to our flora another form of the curious genus *Dewalquea* that is such a striking element in the Upper Cretaceous and Lower Eocene. The only known American species that resembles this new form in any respect is *Dewalquea Smithi* Berry* of the Tuscaloosa and Black Creek formations. The latter is much larger with relatively broader leaflets which have less prominently serrate margins and partially craspedodrome venation.

Dewalquea insigniformis is, however, as its name indicates, very much like *Dewalquea insignis* Hosius and V. d. Marck,† a prominent species in the Campanian and Maestrichtian substages of Europe. The latter has relatively broader, less prominently toothed leaflets, sometimes as many as seven in number, and the venation is said to be craspedodrome. The latter is, however, a character of slight value since entire and toothed leaflets generally occur together and I imagine that *Dewalquea insignis* is merely a serrate form of the associated *Dewalquea haldemiana* Saporta and Marion. If the latter had prominent serrate teeth added it would be identical with *Dewalquea insigniformis*.

The latter is represented by a large number of fragmentary specimens from the upper member of the Bingen sand the most perfect of which is shown in solid black in the accompanying figure.

OCCURRÊNCE: Big Railroad Cut, one mile southwest of Maxwell Spur; Adams Kaolin cuts near Murfreesboro, Pike County.

MAGNOLIACEAE

LIRIODENDRON Linné

LIRIODENDRON MEEKII Heer

Liriodendron Meekii Heer; Meek & Hayden, Proc. Phila. Acad. Sci. **10**: 265. 1858; Phyll. Crét. d. Nebr. 21. *pl. 4. f. 3, 4.* 1866.

Leaves of relatively small size, more or less panduriform in outline (described by Newberry as three-lobed with the median lobe emarginate). Length along the midrib 5–10 cm., usually about 5 cm., the Alabama specimen being 4.7 cm. Greatest width, which is toward the base of the leaf, 2.4–7 cm., averaging about 4 cm., the Alabama specimen being 4.3 cm. Lobes more or less well marked, the basal pair directed laterally, and broadly rounded, the upper pair directed diagonally, usually less well marked, rounded at the outside and inclined toward angularity at the tip. Lateral sinuses more or less indented in the typical forms, such as the Alabama specimen figured, extending nearly half way to the midrib and broadly rounded. Apical sinus wide and open, usually cuneate in outline. Base somewhat descending close to the midrib, broadly and somewhat curved-cuneate. Midrib stout, straight, or somewhat curved. Secondaries thin, parallel, about six pairs branching from the midrib at angles of over 45 degrees and gently curving upward toward their extremities, probably camptodrome, their ultimate course not made out.

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* Berry, E. W. Torreya **10**: 34–38. *f. 1.* 1910.

† Hosius & V. d. Marck. Palaeontographica **26**: 172. *pl. 32. f. 111–113; pl. 33. f. 109; pl. 34. f. 110; pl. 35. f. 123.* 1880.

The mid-Cretaceous leaves, variously described as *Liriodendron Meekii*, *L. primaevum*, *L. semialatum*, and *L. simplex*, are in a state of almost hopeless confusion, due largely to the difficulty of determining the specific lines of cleavage in a probably genetic and variable series of forms.

Liriodendron Meekii was described by Professor Heer in 1858, from the Dakota sandstone of Nebraska, in an appendix to a paper by Meek and Hayden. It was described as trilobate and was figured, but was compared with the European *Liriodendron Procacinii* Unger and with the living *Liriodendron Tulipifera* Linné. In 1866 the same author returns to this subject, figuring the two well-known specimens, which figures have been reproduced by both Lesquereux and Newberry. It would seem that this form must be considered as the type of this species and the present writer so considers it. However, Heer, in describing the Atane flora of Greenland in 1882, in returning to this subject, considers this form, as well as various simple emarginate *Liriodendropsis*-like forms, as different varieties of *Liriodendron Meekii*, and in this he was subsequently followed by Lesquereux, but not by Newberry, who insisted upon the distinctness of the lobate form. We find one of these varieties of Heer's *Liriodendron Meekii genuina* which may belong here, although the leaves are exceptionally large and poorly preserved. Another variety, *Liriodendron Meekii primaeva*, includes the slightly lobate forms subsequently referred to *Liriodendron primaevum* Newberry. It would seem that the small entire retuse leaves which have been variously referred to *Leguminosites*, *Bumelia*, *Bignonia*, *Liriodendron Meekii*, and *L. primaevum*, as well as to *Liriodendron simplex* and to the genus *Liriodendropsis*, are more probably allied to the Leguminoseae than to *Liriodendron*, and they are so considered in the present study. On the other hand, *Liriodendron Meekii* is restricted to include only such lobate forms as do not seem to be specifically distinct from the originally figured types, and with them are merged those forms usually referred to *Liriodendron primaevum* Newberry, which are simply variants of the type just mentioned with less prominently developed lobes.

As here delimited the species is found in the Dakota sandstone, in the Raritan formation, or possibly the Magothy formation (morainic material) on Staten Island, somewhat doubtfully in the Atane beds of Greenland, doubtfully in the lower part of the Black Creek formation of North Carolina,* positively in the lower part of the Alabama Tuscaloosa, and doubtfully in the South American Cretaceous and in the Cenomanian of Saxony.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

LIRIODENDRON QUERCIFOLIUM Newberry

Liriodendron quercifolium Newberry, Bull. Torrey Club **14**: 6. *pl. 62. f. 1.* 1887; Fl. Amboy Clays, 81. *pl. 51. f. 1–6.* 1896.

Leaves oblong in general outline, of large size, pinnately divided by narrow sinuses into from two to four lateral lobes. Apex emarginate. Base truncate to somewhat cordate. Length along the midrib 7–9 cm. and probably considerably greater in some specimens since one fragment measures 12 cm. in width. Width in perfect specimens about 9 cm. Lateral lobes ovate in outline with very acute tips, sometimes narrowed proximad giving them an almost obovate outline; intervening lateral sinuses narrow and deeply cut, in some instances reaching nearly to the midrib, rounded.

In some specimens only two main lobes are developed on each side, which are then quite similar to the typical modern leaf. In these cases, however, the upper lobes are divided by a shallow sinus into two sharp lobules. Other specimens show three lobes of equal magnitude on each side, while one of the best specimens has four nearly equal lobes on each side, the basal and apical pairs being somewhat shorter than the medial pairs. This form of leaf is very suggestive of some species of *Quercus*, but its variations, as well as its venation, show that it is related to *Liriodendron*. The petiole is preserved for a considerable length and is very stout, as is the midrib. There is one main secondary traversing each lobe and running directly to its apical point. In addition there are one or more camptodrome secondaries in each lobe which anastomose with branches from the main secondary, their number being dependent upon the relative width of the lobe; they branch from the midrib at angles of about sixty degrees.

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* Berry, Bull. Torrey Club 34: 197. 1907.

At first sight this species appears to differ considerably from *Liriodendron oblongifolium* and from the modern form, but this difference is not nearly as great as it seems, and it is probable that *Liriodendron quercifolium* is simply a variation from the common ancestor of the two species in the direction of *Liriodendron pinnatifidum* Lesq. Numerous leaves of the modern tree can be found with an incipient lobation suggesting *Liriodendron quercifolium*. In these, however, the sinus is comparatively shallow and rounded, so that the general appearance of the two is not markedly similar.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

MENISPERMACEAE

MENISPERMITES Lesquereux

Menispermites integrifolia sp. nov.

Leaves deltoid-ovate in outline, with a short sharply pointed apex and a truncate or slightly cordate peltate base. Length about 6.5 cm. Maximum width, in the basal part of the leaf, about 6.5 cm. Margins entire, full and rounded. Texture subcoriaceous. Petiole missing. Midrib stout, enlarges proximad. Lateral primaries subopposite, suprabasilar, but slightly differentiated from true secondaries, of which they constitute the second pair: they diverge from the midrib at angles of about forty-five degrees or slightly more, are relatively straight for more than half of the distance to the margin where they curve upward and are eventually camptodrome. Secondaries well marked, four or five opposite to alternate pairs, irregularly spaced, one pair below the primaries, camptodrome. Primaries give off on their outer sides, three to five curved camptodrome laterals. Tertiaries thin percurrent with occasional laterals from midrib parallel with secondaries.

The present species is not at all trilobate as are some of the Dakota sandstone species, from which it also differs in having camptodrome instead of craspedodrome lateral primaries. Among described forms it is like some of the New Jersey Raritan leaves that Newberry referred to *Menispermites borealis* Heer, without greatly resembling the type material of the latter species. The most similar figured form is Newberry's *pl. 50. fig. 2*, Fl. Amboy Clays, which differs from the present species in its inequilateral form. Superficially *Menispermites integrifolia* suggests the associated *Cordia apiculata* (Hollick) Berry, differing especially in its peltate base. It may be also compared with various Upper Cretaceous leaves commonly referred to *Populus*, some of which have been referred by various students to *Cocculus*. The latter genus seems to be the closest to the fossil but in view of the uncertainty of such a reference *Menispermites* will serve equally well as a generic designation for leaves of the family Menispermaceae.

The present species is represented by incomplete specimens in the upper member of the Bingen sand which it is inadvisable to figure. The foregoing description is based on the complete type material from the Tuscaloosa formation of Alabama which will be figured in a report on the Cretaceous Floras of the Eastern Gulf region now going through the press of the United States Geological Survey.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

ROSALES

LEGUMINOSAE

COLUTEA Linné

COLUTEA PRIMORDIALIS Heer

Colutea primordialis Heer, Fl. Foss. Arct. 6^2: 99. *pl. 27. f. 7–11; pl. 43. f. 7, 8.* 1882.

This species was described from the Atane beds of west Greenland and subsequently recorded from the Dakota sandstone of Kansas, the Raritan formation of New Jersey, and the Magothy formation of Marthas Vineyard, Long Island and Maryland. It is represented by a single specimen in the collection from the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

LEGUMINOSITES Bowerbank

LEGUMINOSITES OMPHALOBIOIDES Lesquereux

Leguminosites omphalobioides Lesquereux, Mon. U. S. Geol. Surv. **17**: 149. *pl. 38. f. 4.* 1892.

Leaflets elliptical in outline, 3.2–4 cm. in length by 1.5–1.7 cm. in greatest breadth, which is about half-way between the apex and the base. Texture subcoriaceous. Apex rather broadly rounded. Base slightly narrowed and decurrent to the point of attachment. Lesquereux speaks of a short petiole, but this is lacking in his type figure and in all the specimens examined by the writer. The midrib is not especially wide, but is quite prominent. The secondaries are thin and alternate; they number about six pairs, and branch from the midrib at angles of fifty degrees, or somewhat less, curving upward close to the margins, camptodrome.

This species was described originally from the Dakota sandstone of Kansas, and subsequently found in the Magothy formation of Maryland and the Tuscaloosa formation of Alabama. It is represented by a single, but characteristic specimen in the collection from the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

GERANIALES

EUPHORBIACEAE

MANIHOTITES Berry

MANIHOTITES GEORGIANA Berry

Manihotites georgiana Berry, Bull. Torrey Club **37**: 507. *f. 1, 2.* 1910; U. S. Dept. Int. Geol. Surv. Professional Paper 84: 114. *pls. 22; 23; 24. f. 4, 5.* 1914.

Leaves of extraordinarily large size, 36–48 cm. across, palmately and deeply lobate, the main lobes dichotomously sublobate. Base missing, probably peltate. Margins entire, more or less undulate. Texture coriaceous. Venation coarse. Five or six stout primaries diverge at acute angles from the top of the petiole and fork dichotomously about 5–6 cm. above their base at angles of thirty to fifty degrees. These branches may again fork dichotomously in a distance of 4–6 cm., or may not give off any branches, or the branches may be clearly subsidiary in size and run to the apex of a subordinate lobe. There are a sparse number of relatively fine secondaries, which diverge at angles of about forty-five degrees or more and are apparently camptodrome. In each of the large specimens a straight vein of secondary size runs directly to the base of a single main sinus. It is possible that this vein diverges along the margin in a vein which forms a marginal hem, as in the sinuses of lobed sassafras leaves, but such a vein can not be made out, although at one point there is such a marginal vein connected with the main venation by straight transverse tertiaries. Deep and narrow but rounded sinuses approach within 3–5 cm. of the base and divide the leaf into five or more major lobes; these are subdivided by more or less deep sinuses of a similar character into inequilateral, ovate lanceolate, obtusely pointed subordinate lobes.

This remarkable species was described from perfect material from the lower Eutaw of western Georgia although the leaves are so large that it is usually represented by fragmentary specimens. It occurs in the Eutaw and Ripley of western Tennessee, in the Ripley of Georgia and in the Black Creek formation of North Carolina. Several broken specimens have been collected from the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

SAPINDALES

SAPINDACEAE

SAPINDUS Linné

SAPINDUS MORRISONI Heer

Sapindus Morrisoni Heer, Fl. Foss. Arct. 6^2: 96. *pl. 40. f. 1; pl. 41. f. 3; pl. 43. f. 1a, b; pl. 44. f. 7, 8.* 1882; Ibid. **7**: 39. *pl. 65. f. 5.* 1883.

Leaflets of variable, usually large size, lanceolate and more or less inequilateral in outline, with a broadly cuneate or rounded base and a pointed tip. Petiolulate. Texture subcoriaceous.

Margins entire. Midrib stout, curved. Secondaries numerous, camptodrome.

The present species was described originally by Heer, to whom it must be credited, from west Greenland although based on Lesquereux's manuscript which appeared in print the following year. It is common in the Dakota sandstone and in the Magothy formation of the northern Atlantic coastal plain and occurs in the Woodbine formation of the Western Gulf area, and the Tuscaloosa formation of the Eastern Gulf area. Not uncommon in both the lower and upper members of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County: Mine Creek, three and one half miles north of Nashville, Howard County.

THYMELEALES

LAURACEAE

CINNAMOMUM Blume

CINNAMOMUM NEWBERRYI Berry (?)

Cinnamomum intermedium Newberry, Fl. Amboy Clays, 89. *pl. 29. f. 1–8, 10.* 1896. Not Ettingshausen.

Cinnamomum Newberryi Berry, Bull. Torrey Bot. Club **38**: 423. 1911.

This widespread species has a considerable geological as well as geographical range. Found from western Greenland to Kansas, Iowa and Alabama it ranges from the lower Raritan upward to the lower Eutaw. It is common in the lower Tuscaloosa of western Alabama and is only doubtfully identified from the lower member of the Bingen sand.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

ERICALES

ERICACEAE

ANDROMEDA PARLATORII Heer

Andromeda Parlatorii Heer, Phyll. Crét. d. Nebr. 18. *pl. 1. f. 5.* 1866.

The species is found from Greenland to Nebraska and Alabama, and from the Raritan upward to the Black Creek formation. It is common in the Tuscaloosa formation of western Alabama but has not heretofore been collected from the Upper Cretaceous of the Western Gulf area. It is present in the lower, but has not as yet been recognized in the upper member of the Bingen sand.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

ANDROMEDA NOVAE-CAESAREAE Hollick

Andromeda novae-caesareae Hollick; Newberry, Mon. U. S. Geol. Surv. **26**: 121. *pl. 42. f. 9–12, 28–31.* 1896; Berry, U. S. Dept. Int. Geol. Surv. Professional Paper 84: 58, 120. *pl. 14. f. 5, 6; pl. 24. f. 1.* 1914.

Leaves small, thick, and entire, with stout petioles and midribs and obscure secondary venation which is immersed in the thick lamina. Length 2.5–5.0 cm. Width varying from 0.9–1.3 cm. Venation, where visible, showing numerous parallel, camptodrome, relatively long and thin secondaries which branch from the midrib at acute angles. While the majority of these leaves are equally acuminate at both ends there is considerable variation in this respect, and a well-marked tendency is shown in a considerable number of specimens which are relatively broader, especially in the upper half, toward an obtusely rounded apex, the termination of the midrib showing as a small mucronate point. The base in these forms gradually narrows to the stout petiole.

This species is found as early as the uppermost Raritan in the New Jersey area and is also common in the everlying Magothy. It is exceedingly common throughout the Black Creek formation of the Carolinas and has also been recorded from the Cusseta sand member of the Ripley formation in Georgia, and from the Eutaw formation of Tennessee. It occurs also in the Woodbine of Texas and the Tuscaloosa of Alabama so that it is apparently a form with a wide stratigraphic range.

OCCURRENCE: Mine Creek, three and one half miles north of Nashville, Howard County.

POLEMONIALES

BORAGINACEAE

CORDIA Linné

CORDIA APICULATA (Hollick) Berry

Populus apiculata Hollick, Trans. N. Y. Acad. Sci. **12**: 4. *pl. 3. f. 2.* 1892.

Cordia apiculata Berry, Md. Geol. Surv. Upper Cretaceous, 897. *pl. 90. f. 6.* 1916.

Leaves variable in size and shape, ovate to orbicular in general outline, 5–10 cm. in length by 3–7 cm. in maximum width, which is at or below the middle. Apex usually somewhat abruptly produced into an acuminate tip. Base cuneate and slightly decurrent to rounded or almost truncate. Margins entire, sometimes slightly repand. Petiole of medium length, stout. Midrib mediumly stout, often flexuous. Secondaries five or six pairs, subopposite below, alternate above, slender, branching from the midrib at angles of from forty-five to fifty degrees and arching upward, camptodrome. Tertiaries camptodrome in the marginal region, percurrent internally.

This species in all its characters suggests most strongly the existing *Cordia sebestena* Linné which ranges from the Florida Keys to New Guinea. It also suggests *Cordia tremula* Griesbach of the West Indies, and there is a general generic likeness to various other existing species of this genus. *Cordia* leaves are variable and tend to have more or less toothed margins as is sometimes the case in *Cordia sebestena*, but they are in general entire or slightly repand, and like the fossil somewhat variable. *Cordia* is certainly represented in the Lower Eocene flora of the Gulf region by forms that may be descendants of this Upper Cretaceous species. The present form has been recorded from New Jersey, Staten Island, Long Island, and Delaware, and is not rare in the lower beds of the Tuscaloosa formation in the Alabama region.

Represented by a single specimen in the present collection from the upper member of the Bingen sand.

OCCURRENCE: Big Railroad Cut, one mile southwest of Maxwell Spur, Pike County.

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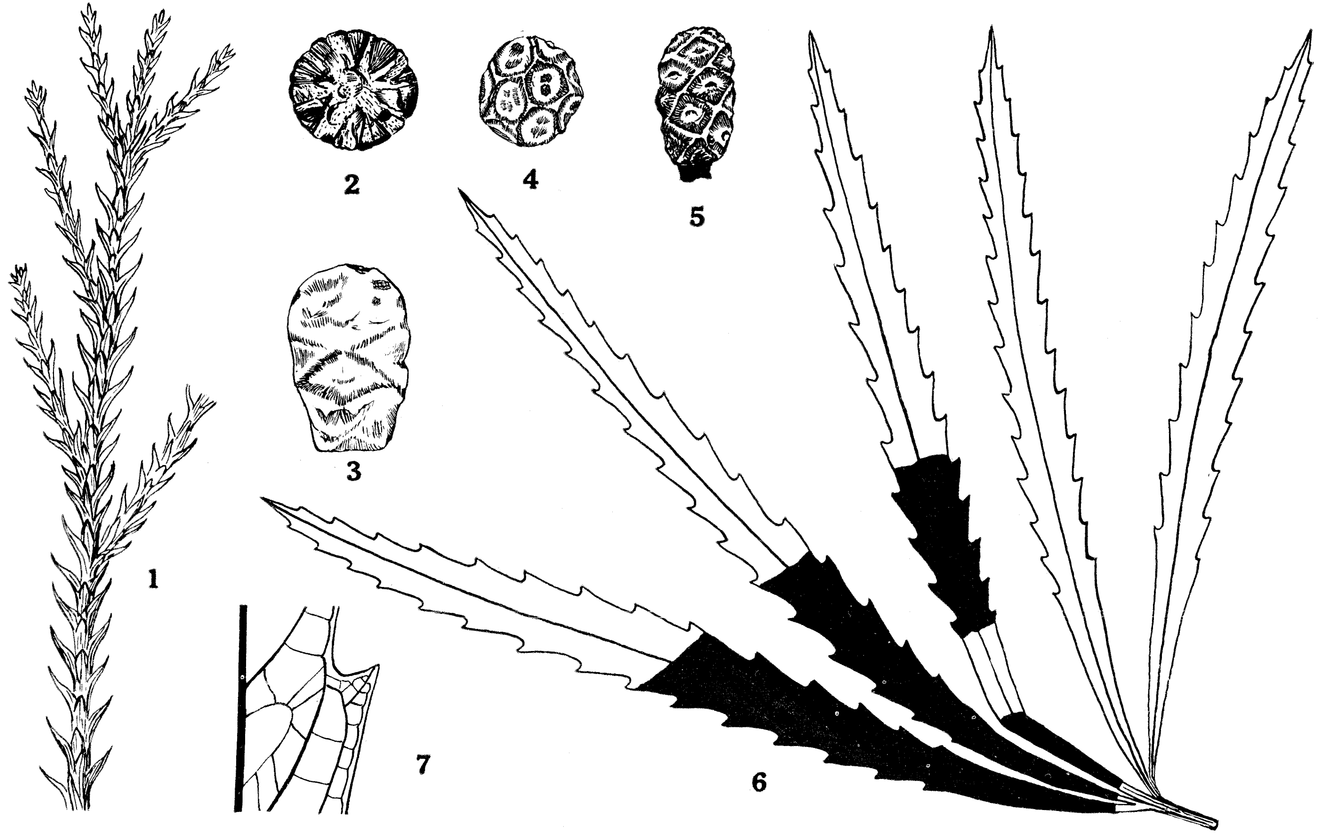
Explanation of plate 4

SEQUOIA CONCINNA Heer

FIG. 1. Foliage from the Bingen sand.
FIG. 2. Cone from the Bingen sand.
FIGS. 3–5. Heretofore unfigured cones from the Magothy formation at Cliffwood Bluff, New Jersey.

DEWALQUEA INSIGNIFORMIS Berry

FIG. 6. Showing the leaf habit.
FIG. 7. Showing venation, × 3.



1–5. SEQUOIA CONCINNA Heer
6, 7. DEWALQUEA INSIGNIFORMIS Berry